Development and Testing of Compression Technologies Using Advanced Materials for Mechanical Counter-Pressure Planetary Exploration Suits

Completed Technology Project (2011 - 2015)

Project Introduction

Mechanical counterpressure (MCP) space suits have the potential to greatly improve the mobility of astronauts as they conduct planetary exploration activities. MCP suits, which differ from traditional gas-pressurized space suits by applying surface pressure to the wearer using tight-fitting materials rather than pressurized gas, represent a fundamental change in space suit design. Traditional gas-pressurized suits are highly resistive to astronaut motion because they require the user to work against the pressurized gas while performing EVA tasks. By altering the pressurization mechanism, MCP suits avoid the pitfall of working against the suit, and offer an added benefit of acting like a second-skin to the wearer, vastly reducing the mass of the suit while simultaneously mitigating the risk of catastrophic failures due to puncture or depressurization. As a result, MCP suits represent a promising breakthrough technology for future exploration missions. While MCP suits were first proposed over 30 years ago, challenges still exist to realize flight implementation. The underlying technologies required to provide uniform compression at sufficient pressures for space exploration have not yet been perfected, and donning and doffing of such a suit remains a significant challenge. The most promising solution to both of these problems lies in advanced materials technology: the development of a hybrid material combining passive elastics with integrated active elements could lead to smart fabrics capable of altering their compression characteristics upon activation. Such a technology would bring MCP suits much closer to operational viability (and could be leveraged for other purposes, especially in the medical and sports technology industries). The research objectives of this proposed effort are to: Assess the state of the art of passive compression elastics to determine baseline capabilities Investigate active material technologies that demonstrate potential to achieve 30 kPa (4.3 PSI) compression throughout the garment Design, fabricate, and test hybrid materials combining passive and active compression components, and assess both their performance at providing uniform pressure of sufficient magnitude and ease of donning/doffing Quantify the mobility characteristics of MCP concepts relative to their gas-pressurized counterparts Provide recommendations for future hybrid designs based on quantitative measurements Active material candidates will be assessed based on their stress/strain characteristics, activation mechanisms, as well as their potential for integration into a wearable garment. MCP suit garments will be tested to assess their capability both at providing uniform compression at sufficient magnitudes as well as their mobility characteristics relative to traditional space suits.

Anticipated Benefits

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Project Image Development and Testing of Compression Technologies Using Advanced Materials for Mechanical Counter-Pressure Planetary Exploration Suits

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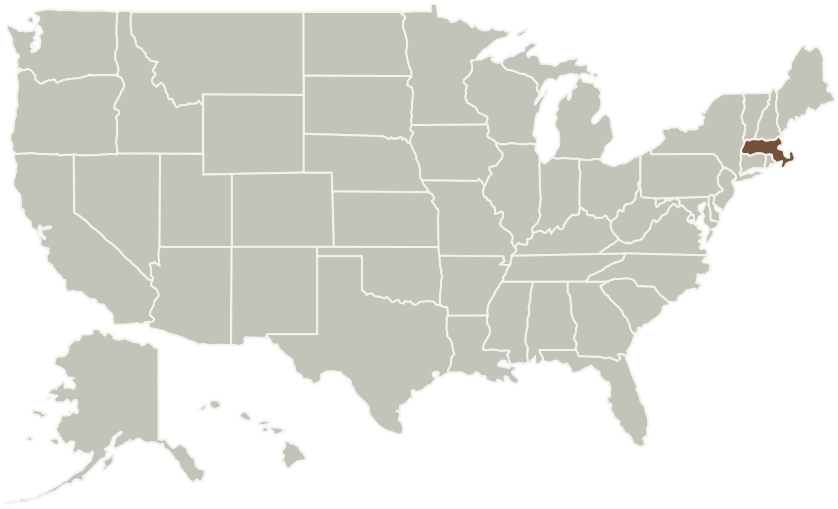
Primary U.S. Work Locations and Key Partners



Primary U.S. Work Locations
Massachusetts

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Responsible Program:

Space Technology Research Grants

Project Management

Program Director:

Claudia M Meyer

Program Manager:

Hung D Nguyen

Principal Investigator:

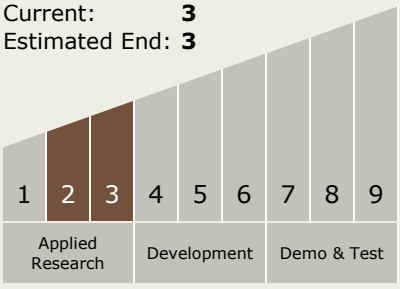
Dava J Newman

Co-Investigator:

Bradley T Holschuh

Technology Maturity (TRL)

Start: **2**
Current: **3**
Estimated End: **3**



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Images

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Project Image Development and Testing of Compression Technologies Using Advanced Materials for Mechanical Counter-Pressure Planetary Exploration Suits
(https://techport.nasa.gov/image/1745)

Project Website:

https://www.nasa.gov/directorates/spacetech/home/index.html

Technology Areas

Primary:

- TX06 Human Health, Life Support, and Habitation Systems
  - TX06.2 Extravehicular Activity Systems
    - TX06.2.1 Pressure Garment